CLAIMS

What is Claimed is:

1. A method of estimating a momentum to be removed from a spacecraft:

generating a plurality of spacecraft momentum measurements;

fitting the plurality of spacecraft momentum measurements to a parametric model of a spacecraft momentum profile having a time period of t_p;

determining the momentum of the spacecraft from the parametric model; and

generating an estimate of the momentum to be removed from the spacecraft at least in part from the determined momentum of the spacecraft.

2. The method of claim 1, wherein the spacecraft comprises a momentum storage device, and wherein the step of generating a plurality of spacecraft momentum measurements comprises the steps of:

measuring the spacecraft angular rate;

measuring an angular rate of a momentum storage device disposed in the satellite; and

computing the momentum of the spacecraft at least in part from the spacecraft angular rate, the momentum storage device angular rate, an inertia of the spacecraft and an inertia of the momentum storage device.

3. The method of claim 1, further comprising the step of filtering the plurality of spacecraft momentum measurements before fitting the spacecraft momentum measurements to the parametric model.

4. The method of claim 1, wherein the periodic spacecraft momentum profile comprises a plurality of segments, each segment modeled by a set of basis functions.

5. The method of claim 4, wherein the set of basis functions is selected from the group comprising:

a polynomial; and

a Fourier series.

6. The method of claim 5, wherein the set of basis functions is a 3rd order polynomial, and each segment is one hour in duration.

7. The method of claim 1, wherein the step of estimating the amount of momentum to be removed from the spacecraft comprises the steps of:

determining a secular momentum residual at least in part from the momentum of the spacecraft determined from the parametric model;

determining a momentum bias error; and

determining the amount of momentum to be removed from the spacecraft at least in part from the measured momentum bias error and the secular momentum residual.

8. The method of claim 7, wherein the step of determining a secular momentum residual at least in part from the momentum of the spacecraft comprises the steps of:

filtering the spacecraft momentum measurements; and

determining a difference between a spacecraft momentum measurement at a scheduled time for removing the momentum from the spacecraft and the estimate of the spacecraft momentum at a time one time period t_p prior to the scheduled time for removing the momentum from the spacecraft.

9. The method of claim 8, wherein the step of determining a momentum bias error comprises the steps of:

determining the measured momentum bias at least in part from $\frac{M_{MAX} + M_{MIN}}{2}$, wherein M_{MAX} is the maximum momentum observed during the time period t_p and M_{MIN} is a minimum momentum observed during the time period t_p; and

determining a the momentum bias error as a difference between the measured momentum bias and a commanded momentum bias.

10. The method of claim 9, wherein spacecraft momentum is at least partially periodic with time period t_p.

11. An apparatus for estimating a momentum to be removed from a spacecraft:

means for generating a plurality of spacecraft momentum measurements;

means for fitting the plurality of spacecraft momentum measurements to a parametric model of a spacecraft momentum profile having a time period of t_p;

means for determining the momentum of the spacecraft from the parametric model; and

means for generating an estimate of the momentum to be removed from the spacecraft at least in part from the determined momentum of the spacecraft.

12. The apparatus of claim 11, wherein the spacecraft comprises a momentum storage device, and wherein the means for generating a plurality of spacecraft momentum measurements comprises:

means for measuring the spacecraft angular rate;

means for measuring an angular rate of a momentum storage device disposed in the satellite; and

means for computing the momentum of the spacecraft at least in part from the spacecraft angular rate, the momentum storage device angular rate, an inertia of the spacecraft and an inertia of the momentum storage device.

13. The apparatus of claim 11, further comprising means for filtering the plurality of spacecraft momentum measurements before fitting the spacecraft momentum measurements to the parametric model.

14. The apparatus of claim 11, wherein the periodic spacecraft momentum profile comprises a plurality of segments, each segment modeled by a set of basis functions.

15. The apparatus of claim 14, wherein the set of basis functions is selected from the group comprising:

a polynomial; and

a Fourier series.

16. The apparatus of claim 15, wherein the set of basis functions is a 3rd order polynomial, and each segment is one hour in duration.

17. The apparatus of claim 11, wherein the means for estimating the amount of momentum to be removed from the spacecraft comprises:

means for determining a secular momentum residual at least in part from the momentum of the spacecraft determined from the parametric model;

means for determining a momentum bias error; and

means for determining the amount of momentum to be removed from the spacecraft at least in part from the measured momentum bias error and the secular momentum residual.

18. The apparatus of claim 17, wherein the means for determining a secular momentum residual at least in part from the momentum of the spacecraft comprises:

means for filtering the spacecraft momentum measurements; and

means for determining a difference between a spacecraft momentum measurement at a scheduled time for removing the momentum from the spacecraft and the estimate of the spacecraft momentum at a time one time period t_p prior to the scheduled time for removing the momentum from the spacecraft.

19. The apparatus of claim 18, wherein the means for determining a momentum bias error comprises:

means for determining the measured momentum bias at least in part from $\frac{M_{MAX} + M_{MIN}}{2}$, wherein M_{MAX} is the maximum momentum observed during the time period t_p and M_{MIN} is a minimum momentum observed during the time period t_p; and

means for determining a the momentum bias error as a difference between the measured momentum bias and a commanded momentum bias.

20. The apparatus of claim 19, wherein spacecraft momentum is at least partially periodic with time period t_p.

21. An apparatus for estimating a momentum to be removed from a spacecraft:

a first module for accepting a plurality of spacecraft momentum measurements and for fitting the plurality of spacecraft momentum measurements to a parametric model of a spacecraft momentum profile having a time period of t_p;

a second module for determining the momentum of the spacecraft from the parametric model; and

a third module for generating an estimate of the momentum to be removed from the spacecraft at least in part from the determined momentum of the spacecraft.

22. The apparatus of claim 21, further comprising a processor, and wherein the first module, the second module, and the third module are software modules comprising instructions performable by the processor.

23. The apparatus of claim 21, further comprising a filter for filtering the plurality of spacecraft momentum measurements before fitting the spacecraft momentum measurements to the parametric model.

24. The apparatus of claim 21, wherein the periodic spacecraft momentum profile comprises a plurality of segments, each segment modeled by a set of basis functions.

25. The apparatus of claim 24, wherein the set of basis functions is selected from the group comprising:

a polynomial; and

a Fourier series.

26. The apparatus of claim 25, wherein the set of basis functions is a 3rd order polynomial, and each segment is one hour in duration.

27. The apparatus of claim 21, wherein the third module comprises:

a fourth module for determining a secular momentum residual at least in part from the momentum of the spacecraft determined from the parametric model;

a fifth module for determining a momentum bias error; and

a sixth module for determining the amount of momentum to be removed from the spacecraft at least in part from the measured momentum bias error and the secular momentum residual.

28. The apparatus of claim 27, wherein:

the apparatus further comprises a filter for filtering the spacecraft momentum measurements; and

the fourth module comprises a differencer for determining a difference between a spacecraft momentum measurement at a scheduled time for removing the momentum from the spacecraft and the estimate of the spacecraft momentum at a time one time period t_p prior to the scheduled time for removing the momentum from the spacecraft.

29. The apparatus of claim 27, wherein the fifth module comprises:

a seventh module for determining the measured momentum bias at least in part from $\frac{M_{MAX} + M_{MIN}}{2}$, wherein M_{MAX} is the maximum momentum observed during the time period t_p and M_{MIN} is a minimum momentum observed during the time period t_p; and

an eighth module for determining a the momentum bias error as a difference between the measured momentum bias and a commanded momentum bias.

30. The apparatus of claim 29, wherein spacecraft momentum is at least partially periodic with time period t_p.